

1 radiant burner surface area and the excess combustion
2 air operating air ratio is controlled in the range of
3 30% to 100% (wherein the excess air ratio is defined as
4 percent combustion air in excess of the stoichiometric
5 amount required for complete combustion of the burner
6 fuel) to prevent overheating of the surface of the
7 radiant burner and to prevent overheating of the
8 premixed fuel and oxidant contained within the burner
9 core. In the present invention, the reactant mass
10 velocity is controlled in the range of 400 lb/ft²/h to
11 1500 lb/ft²/h in order to limit the reaction chamber
12 tube wall temperature to the desired range of 1300°F to
13 1500°F.

14 Combustion products emanating from the
15 permeable metal fiber zone 14 enter the inlet 13
16 leading to the convection chamber 17, wherein the
17 combustion products exchange heat with tubular reaction
18 chamber 1 for preheating the feed to leg 1b.

19

20 **EXAMPLE**

21

22 A compact endothermic catalytic reaction
23 apparatus according to the preferred embodiment was
24 constructed and tested. The reaction chamber consisted
25 of 1 inch schedule 40 pipe constructed of 310 stainless

1 steel that was formed in a U-tube arrangement spaced on
2 3 inch centers. The reaction chamber was packed with a
3 commercial steam reforming catalyst that was crushed
4 and screened to an average particle size of
5 approximately $\frac{1}{4}$ inch.

6 The radiant burner consisted of 4 inch long
7 by $1\frac{1}{2}$ inch outer diameter cylindrical assembly that
8 had an active radiant angle γ_1 of 120 degrees. The
9 burner assembly was placed in an insulated combustion
10 chamber having dimensions of 6 inch internal diameter
11 and 10 inch height. The radiant burner assembly was
12 spaced approximately 4 inches from the U-tube
13 centerline. The convection chamber consisted of a 2
14 inch tube constructed of 304 stainless steel.

15 The radiant burner was fired using a mixture
16 of propane and air at a total higher heating value
17 firing rate of 12,000 btu/h. The reactant mixture
18 consisted of 1 lb/h of propane and approximately
19 3.5 lb/h of steam and was fed to the reaction chamber
20 at a temperature of approximately 800°F. The reactant
21 mixture was heated in the reaction chamber to an exit
22 temperature of 1250°F. The measured tube wall
23 temperature of the reaction chamber was 1450°F, the
24 radiant burner surface temperature was 1750°F, and the
25 combustion products exit temperature was 1050°F. The

1 estimated hydrogen plus carbon monoxide yield was 67
2 SCFH.

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4 Fig. 3 depicts another embodiment of the
5 present invention. In this embodiment, a radiant
6 burner surface 30 having a hemispherical geometry
7 radiates energy to the reaction chamber like that of
8 Fig. 1. A mixture of fuel and oxidant enters the
9 radiant burner from an inlet conduit 31. The
10 longitudinal axis of the inlet conduit is oriented
11 normal to the plane of the U-tube reaction chamber.

12 Fig. 4 depicts yet another embodiment of the
13 present invention. In this embodiment, the reaction
14 chamber is defined by a volume enclosed by a tubular
15 reactor conduit comprising an upper section 19
16 consisting of a vertically disposed tube that is
17 connected to the inlet means 2, a lower section 20
18 consisting of a helical coil, having an outer diameter
19 between 6 and 36 inches, and an exit section 21
20 consisting of a vertically disposed tube that is
21 connected to an exit means 3. The upper section 19 of
22 the tubular reactor conduit passes concentrically
23 through the convection chamber 17. The reaction
24 chamber is packed with catalyst from the inlet means 2,
25 where reactants enter, to the outlet zone 22 of the